INSTRUCTIONS

PRESSURIZED COOLING-WATER SYSTEM

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DESCRIPTION

COMPONENTS

The locomotive pressurized cooling-water system, Fig. 1, maintains an essentially constant engine operating temperature throughout its load range and with wide variations in ambient temperature.

*Revisions are indicated by marginal bars.

The principal components in the system are as follows:

1. Water storage tank
2. Lube-oil cooler
3. Water pump
4. Water inlet headers
5. Water discharge header
6. Radiator
7. Interconnecting pipes
8. Diesel engine (turbocharger, intercooler and cylinders).

SYSTEM OPERATION

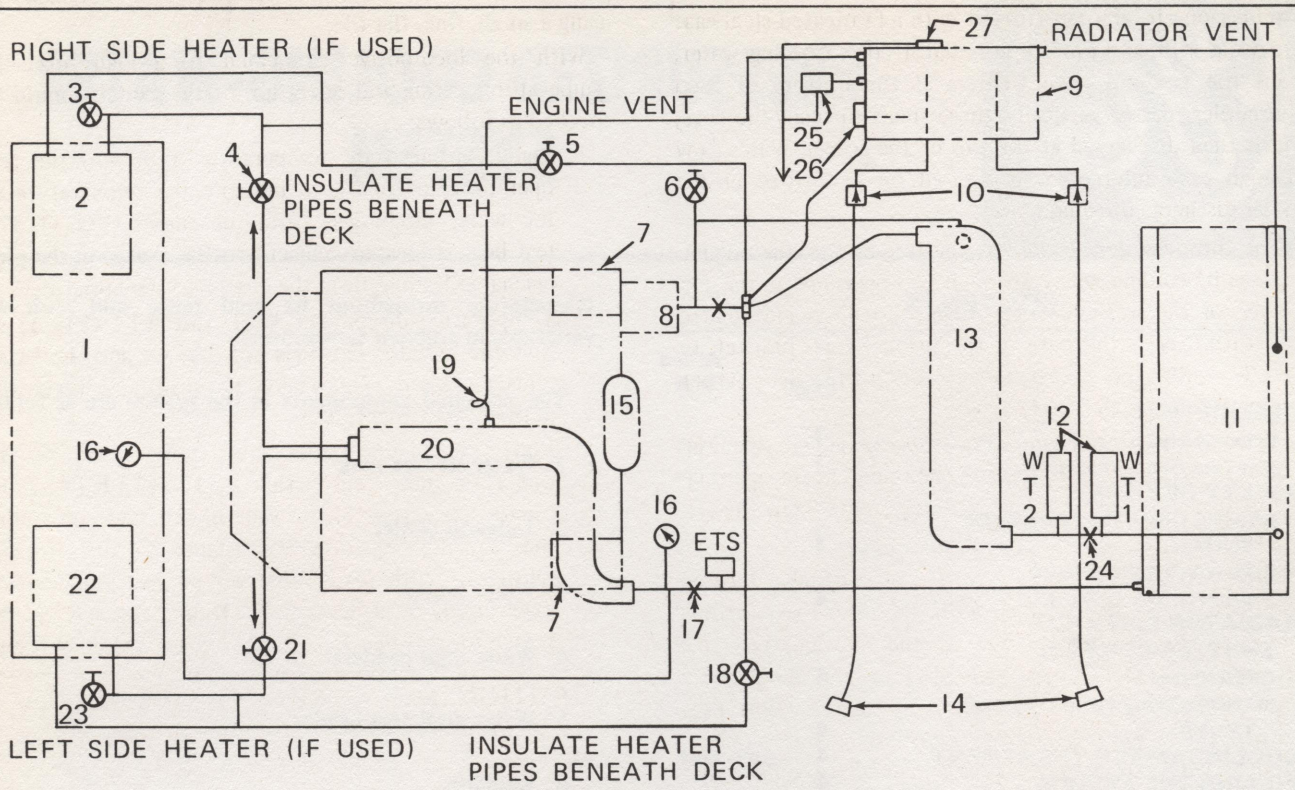
The cooling-water system is of the wet type, in that the entire system contains coolant at all times. One water-fill opening, covered with a pressure cap and a protective cover, is located on top of the cab above the water tank. Two fill openings (if used) are located below the deck, one on each side of the locomotive. See Fig. 2. The below-deck fill lines contain a check valve which aids in maintaining pressure.

Water leaving the radiator is drawn through tubes in the lubricating-oil cooler and is then conducted to the suction side of the engine-driven, centrifugal water pump. The oil cooler is placed in a horizontal position across the platform, normally between the lube-oil filter and engine air filter compartment; in some applications, in the radiator compartment at the rear end of the locomotive.

These instructions do not purport to cover all details or variations in equipment nor to provide for every possible contingency to be met in connection with installation, operation or maintenance. Should further information be desired or should particular problems arise which are not covered sufficiently for the purchaser's purposes, the matter should be referred to the General Electric Company.

Verify numbers for parts, tools, or material by using the Renewal Parts or Tool Catalogs, or contact your General Electric representative for assistance. Do not order from this publication.

GENERAL ELECTRIC



REF.	DESCRIPTION	REF.	DESCRIPTION	REF.	DESCRIPTION
1	OPERATOR'S CAB	11	RADIATOR	20	ENGINE WATER DISCHARGE HEADER
2	CAB HEATER	12	WATER-TEMPERATURE SWITCHES	21	CAB-HEATER SHUT-OFF VALVE
3	CAB HEATER DRAIN VALVE	13	OIL COOLER	22	CAB HEATER
4	CAB HEATER SHUT-OFF VALVE	14	SIDE WATER FILLS (WHEN USED)	23	CAB-HEATER DRAIN VALVE
5	CAB HEATER SHUT-OFF VALVE	15	TURBOCHARGER	24	PIPE BOSS FOR WT1-WT2 TEMPERATURE SWITCH TEST
6	SYSTEM WATER DRAIN VALVE	16	WATER TEMPERATURE GAGE(S) (OPERATOR'S CAB AND/OR IN LINE)	25	PRESSURE RELIEF VALVE
7	INTERCOOLERS	17	PIPE BOSS FOR HIGH-TEMPERATURE SWITCH TEST	26	LOW-WATER-LEVEL SWITCH (WHEN USED)
8	WATER PUMP	18	CAB-HEATER SHUT-OFF VALVE	27	FILL CAP
9	EXPANSION TANK	19	DIESEL-ENGINE LOOP OR HOSE		
10	CHECK VALVES (USED WITH SIDE WATER FILLS, REF. 14)				

FIG. 1, E-17738A

FIG. 1. ENGINE COOLING-WATER SYSTEM.

Water discharged from the pump enters a lateral passage in the free-end cover of the engine, where it is distributed to the water inlet header pipes, the turbocharger, and the intercoolers.

The water inlet headers, one along each side of the engine, distribute cooling water to the cylinders. These headers are comprised of sections which are individually removable. Each section is bolted to its cylinder and connected to adjacent sections by compression pipe couplings.

Each cylinder contains a liner whose outer surface is machined to form two annular water bands. Water from the water inlet header, coming through the jacket wall, is distributed around the liner by the lower water band. It then passes through the 1/8-in. annular space, formed by the distribution dam on the outside diameter of the liner and the inside diameter of the jacket, into the upper water band. From the upper water band, it continues into the head through a large number of holes drilled in the upper liner wall.

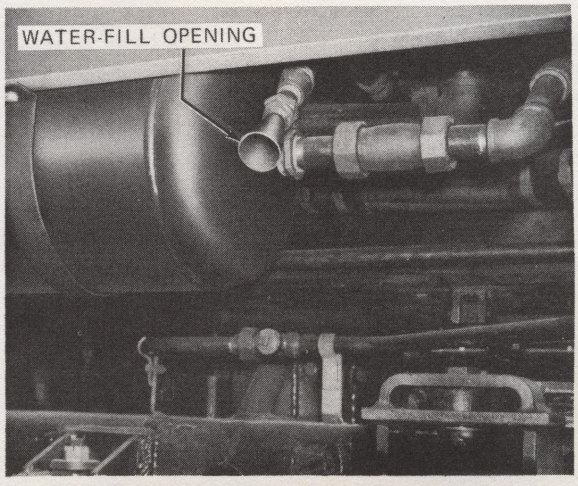


FIG. 2, E-13172

FIG. 2. TYPICAL SIDE WATER FILL OPENING.

The engine intercoolers, which remove heat from combustion air, are constructed with a fabricated-steel case enclosing a fin-and-tube type radiator core. Cooling water, from the free-end cover, enters at the bottom of each intercooler, passes vertically three times through the core, and is then discharged at the top of the cooler. Water flow through each intercooler is limited by an orifice in the cooler discharge opening.

The turbocharger, located at the free end of the engine, receives its cooling water through two openings in the top surface of the free-end cover. These openings are aligned with openings in the base of the turbocharger bracket, or directly with the turbocharger feet, and the mating connections are sealed by O-rings.

Water is discharged from the turbocharger at openings near the top on its exhaust gas inlet side. These openings are, in turn, connected to the discharge pipe from the left intercooler.

The water discharge header is centrally located lengthwise over the engine, with its discharge opening connected to a junction box at the top of the right intercooler. Branch pipes welded into the header are connected to individual cylinders by compression pipe couplings. Water flowing from the intercoolers, turbocharger, and water discharge header combines and returns to the radiator.

High Idle Engine Operation (If Used)

Locomotives having this feature have a temperature switch (HITS) mounted in the water line between the engine and the radiator. If the engine is idling and the coolant temperature drops to approximately* 160 F (71 C), the engine will go into the high idle speed mode, that is, to the equivalent of Notch 3 speed.

SAFETY DEVICES

ENGINE HIGH-TEMPERATURE SWITCH

The engine high-temperature switch is mounted in the engine-water discharge pipe to the radiator. The switch is a thermal-electrical safety device which alerts the operator if the engine temperature becomes excessive. When the temperature of the water discharged from the engine reaches the temperature setting of the switch, its electrical contacts will close, energizing a light and/or bell in the operator's cab.

To assure proper operation, the switch should, preferably, be inspected and tested while in place on the locomotive. This should be done during scheduled maintenance when the locomotive is being load box tested. An alternative is to remove the temperature switch and check its operation in a hotpot.

With the switch in place, remove the cover plate and ascertain the electrical connections are secure and the contacts are in good condition. The contacts, if burned or pitted, may be dressed (with the circuit de-energized) by using a small, fine, flat file.

With the locomotive connected to a load box, the temperature setting and operation of the switch should be checked as follows:

1. Install an accurate temperature gage into the test opening (pipe boss), to measure the temperature of the water discharged from the engine (Fig. 1). The test boss is located adjacent to the switch in the pipe discharge leading from the engine to the radiator.
2. Temporarily disconnect WT1 and WT2 (Fig. 1) so that the radiator fan does not operate and the hatch remains closed. This makes it possible to reach the desired test temperature.
3. Start the engine and allow it to reach normal operating temperature, that is, 170-175 F (77-79 C) on the test gage. Then, with an assistant controlling the throttle, operate the engine at full throttle (Notch 8) with load. Observe the test temperature gage closely until the switch setting is reached and the switch closes. See DATA section for switch settings.

CAUTION: *When conducting this test, do not allow the temperature of the cooling water discharged from the engine to exceed 205 F (96 C).*

4. Immediately after the switch contacts close, reduce the engine speed to idle and connect WT1. This will allow the temperature of the cooling system to drop slowly. Observe the temperature at which the switch contacts open. See DATA section for switch drop-out settings.

Should the switch require adjustment, its closing and opening settings can be raised or lowered by turning the external range adjustment screw on the switch case. The differential setting of the switch should not be adjusted.

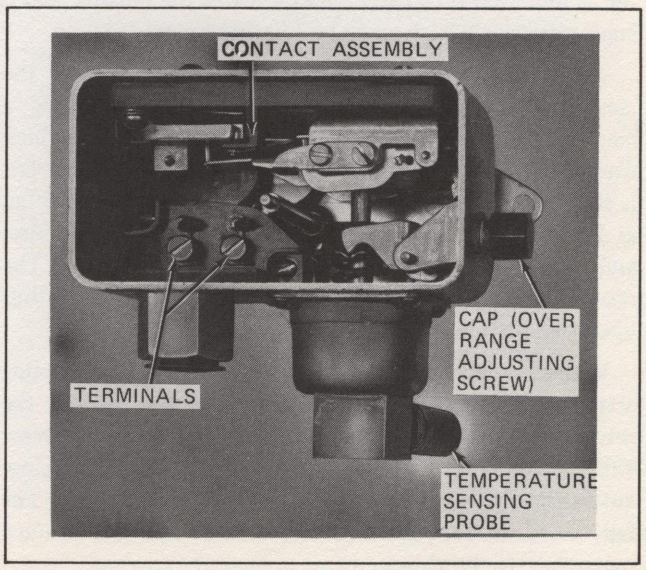


FIG. 3. TEMPERATURE SWITCH.

FIG. 3, E-21622

*Some customers use 150 F (66 C) for engine to go into high idle. Check schematic for varification.

When checking an engine high-temperature switch that has been removed from the locomotive, immerse the switch temperature-sensing probe in a pot of agitated water or oil. Slowly raise the water or oil temperature until the switch contacts close. Lower the water or oil temperature until the contacts open. If necessary, reset the switch to obtain the proper opening and closing values. See DATA section for correct values.

LOW-WATER-PRESSURE SHUTDOWN DEVICE

The low-water-pressure shutdown device is an automatic safety device used to shut down the engine in the event of cooling-water failure.

This device is mounted in the engine control governor and is piped to the right-bank water inlet header.

If the pressure of the cooling water supplied to the engine cylinders drops below that required for safe operation of the engine, the water-pressure device will function to shut down the engine. For operation and adjustment details refer to Engine Control Governor instructions.

RADIATOR FAN AND SHUTTER CONTROL

OPERATION

Two water-temperature-sensing contact switches (WT1 and WT2), Fig. 1, are located in the radiator water outlet pipe below and just forward of the radiator fan. These switches automatically control the opening and closing of the radiator shutters (if used) and the speed of the fan.

The shutter assembly is mounted directly over the radiator. It is spring-loaded for automatic closing and is opened by an air-operated shutter cylinder. The radiator fan is mounted on a shaft directly below the radiator and is engine-driven through an eddy-current clutch.

When water temperature increases and reaches the closing setting of WT1, this switch closes, actuating a magnetically-operated air valve (magnet valve), which causes the radiator shutter to open. Simultaneously, current is supplied to the fan clutch, enabling it to operate the fan at low speed. If the water temperature continues to rise, and reaches the setting of WT2, this switch closes. The result is that the fan clutch receives additional current, thus operating the fan at high speed.

When the water temperature drops below the opening setting of WT2, the contacts open and the radiator fan returns to low speed. If the water temperature drops below the opening setting of WT1, the shutter will close automatically and the fan clutch will be de-energized. The fan will continue to rotate slowly, due to residual magnetism in the clutch.

MANUAL SHUTTER-CONTROL LEVER (See Fig. 4)

The lever for manual control of the shutter is located behind the headlights in the radiator fan compartment. This lever is provided in the event of a failure in the automatic shutter control system. To open the shutters, pull the locking pin out and push the lever away from the headlights. To hold open, replace the locking pin. To close the shutters, remove the locking pin. The shutters are spring-loaded and will close automatically.

An extension for the manual shutter control lever is provided (see Fig. 4). The purpose of the extension is to provide more leverage and make manual operation of the lever easier.

COOLING WATER TREATMENT

Refer to publication GET-2594, Cooling Water for Diesel Engines.

FILLING THE SYSTEM

The locomotive cooling system can be filled through the opening on top of the water tank (see Fig. 5), or through either of the fill pipes (if used) located below the deck (see Fig. 2). One fill pipe is located on each side of the locomotive, to facilitate filling from either side. Removing the pressure cap on the water tank opening while filling the system through the below-deck fill pipes will speed up the operation by allowing trapped air to vent without restriction.

The water-level sight gage is located on the water storage tank. The sight gage should be three-quarters full when the engine is at idle.

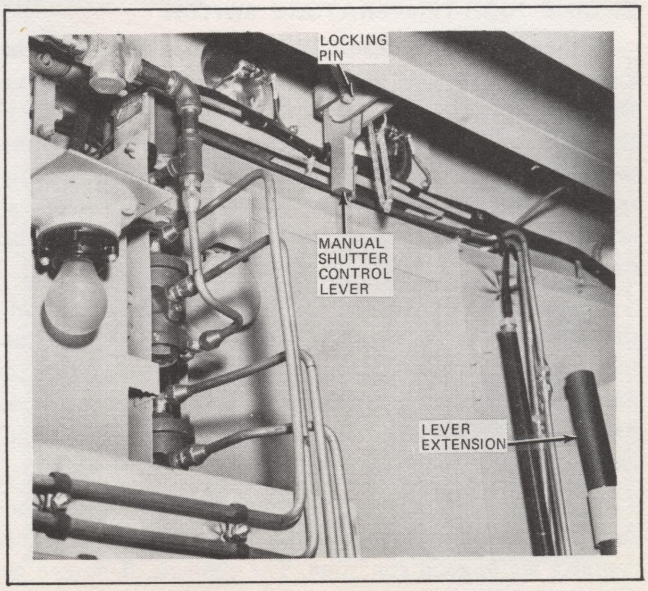


FIG. 4, E-13173

FIG. 4. LOCATION OF RADIATOR CAB EQUIPMENT.

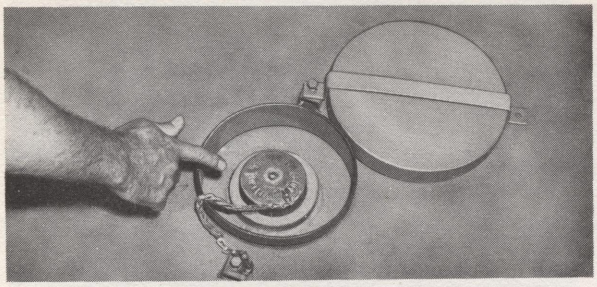


FIG. 5, E-13174

FIG. 5. TYPICAL TOP WATER FILL WITH OPTIONAL COVER.

After filling the system from a completely drained condition, adjust the water to the proper level with the engine idling, to allow trapped air to vent from the system.

DRAINING THE SYSTEM (See Fig. 1)

To completely drain the water system, proceed as follows:

1. Remove the cap from the end of the system water drain pipe (located under the side of the platform), then open the system water drain valve, located on the right side of the platform near the free end of the engine.
2. Remove the plug from the cab heater drain line(s), and open the cab heater drain valve(s).
3. Remove the plug from the water pump impeller casing.

COOLING SYSTEM MAINTENANCE

RADIATOR CLEANING (EXTERIOR) IN THE LOCOMOTIVE

To maintain efficient radiator operation, the radiator must be kept clean. The frequency of cleaning will be determined by the rate of dirt accumulation on the radiator. In most cases, blowing downward through the radiator core with compressed air will be sufficient to remove dry dust and dirt.

WARNING: *To prevent injury, personnel should wear eye protection when cleaning with compressed air.*

This should be done with the engine stopped. If more intensive cleaning is needed, it can be done best in the following manner:

1. Remove the hood with the protective screen from the radiator compartment.
2. Prepare a cleaning solution. See the cleaning materials listed in the DATA section.
3. Cover the equipment below, using plastic drop cloths or other water repellent material to prevent dirt and solution from contaminating the equipment.
4. Using a portable steam cleaner or similar equipment, blast the solution downward through fins and tubes, opposite to normal air flow. Continue the cleaning operation until all sections of the radiator are clean.

SYSTEM CLEANING (INTERIOR)

1. Drain and flush the entire cooling-water system.
2. Fill with warm cleaning solution; see the cleaning materials listed in the DATA section.
3. Operate the engine for one hour (or 1/2 hour after normal operating temperature has been reached) to purge contamination, including grease and oil deposits, from the walls of the cooling system and to disperse the contaminants into solution.
4. Drain and flush the system with clear water.

NOTE: *Step 5 should be performed only when large deposits of scale are known to be in the system.*

5. Fill the system with de-scaling solution. (See DATA section.) Circulate the solution for 10 minutes, using an acid-resistant pump and a tank with 50 gal. of additional solution. The same equipment that is used to de-scale the steam generator on passenger locomotives may be used. If such equipment is not available in the shop, then operate the engine for five minutes.

   This operation will remove the water scale from the interior of the cooling system. Scale often accumulates from the use of inadequately-treated water resulting from the common and very poor practice of adding untreated water at outlying points. In addition, rust or corrosion, which may have occurred from running with insufficient inhibitor in the system, will be removed. Drain and flush with clear water before filling with treated water.

RADIATORS

REMOVAL FROM LOCOMOTIVE (See Figs. 6 and 7)

After the system is drained (see DRAINING THE SYSTEM section), the following procedure should be used when it is necessary to remove the radiator from the locomotive for cleaning or repair:

1. Remove the protective hatch from the radiator compartment with an overhead crane.
2. Detach the shutter control linkage.
3. Remove the water inlet and water outlet fittings.
4. Disconnect the vent line at the coupling located in front of and above the radiator.
5. Remove the bolts fastening the radiator to the radiator compartment frame.

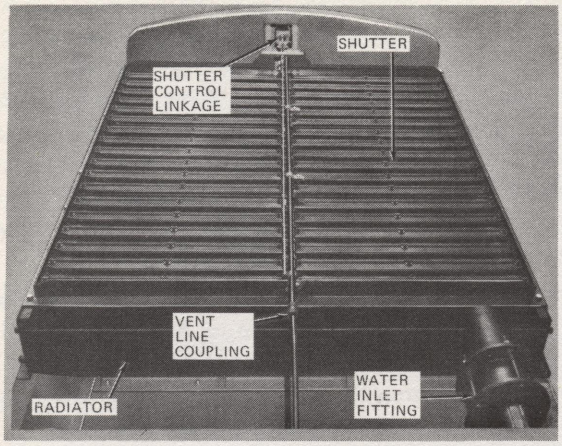


FIG. 6. RADIATOR AND SHUTTER DETAILS.

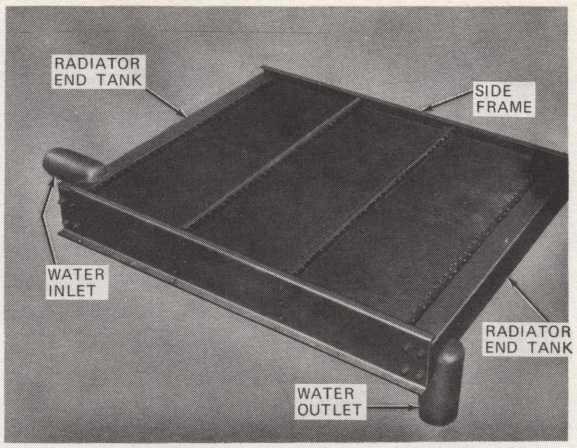


FIG. 7. RADIATOR DETAILS.

FIG. 6, E-13175

FIG. 7, E-13176

6. Carefully lift the radiator and shutter assembly away from the locomotive with a crane. Be certain the lifting arrangement is such that the radiator will not be twisted or strained while it is being removed. Set the radiator on level blocking. Put supports under the radiator side frames.

RADIATOR CLEANING AND TESTING

Removed from Locomotive

After long service, or at periods of general overhaul, the radiator should be removed from the locomotive for thorough cleaning and testing.

The equipment necessary to perform the job properly is as follows:

1. Three tanks large enough to hold the submerged radiator core for cleaning, de-scaling and rinsing and equipped with steam coils, or some other method of heating
2. Gas welding torch and equipment
3. Chemical cleaning and de-scaling compounds
4. Soldering and brazing supplies
5. A source of 20-psi air or water pressure for testing
6. Brushes and rods to assist in removing scale from the tubes.

Cleaning

1. Support the radiator on a bench or on wooden horses. Disassemble by removing the bolted end tanks and side frames.

CAUTION: *Use extreme care when handling radiator cores, since any damage to the tubes or fins may impair their operating efficiency.*

2. Clean oily dirt, sludge and paint from the core and other parts by suspending then in a cleaning tank containing a solution of 8 oz. per gallon of water of Turco Ferrex* B, or Oakite Stripper** R6 or M3, or equivalent. With the tank operating at a rolling boil, leave the parts immersed for approximately 30 minutes.

NOTE: *Maintain the strength of the cleaning solution by adding compound, as required.*

3. Thoroughly rinse the core and parts in another tank containing clean water heated to 212 F (100 C). This tank should have a constant overflow to maintain efficient rinsing action and to remove sludge from the surface of the water.

4. To remove the remaining scale from the core tubes, briefly suspend the cores in an acid-proof tank containing a cold solution of 10 percent Turco De-scaler, 15 percent Oakite 32, or equivalent. Ten minutes is the average time required to remove scale from the tubes. Removal of carbonate scale will be indicated by the formation of gas bubbles; when complete, gassing will stop. However, to assure complete removal, the core should remain in the solution an additional five minutes after gassing has stopped.

NOTE: *Full strength of the de-scaling solution should be maintained by periodic addition of compound, as required.*

*Product of Turco Products, Inc.
**Product of Oakite Products, Inc.

5. Rinse the core in hot water, as described in Step 3.

6. Dip the core briefly in the cleaning solution described in Step 2, to neutralize any residual acid.

7. Rinse as in Step 3.

8. Reassemble the radiator, using new gaskets between the tanks and core.

Testing

Two equally suitable methods may be used to test the radiator sections for leaks:

1. They may be pressurized with controlled air pressure of 20 psi maximum and submerged in water to detect leakage bubbles.

2. They may be hydrostatically tested using 20 psi maximum water pressure, in which case the outer surfaces of the core and tanks should be completely dry, to permit detection of leaks.

INSTALLATION IN LOCOMOTIVE

1. Lower the radiator and shutter assembly into position with an overhead crane.

2. Install the bolts and spacers which fasten the radiator to the radiator compartment frame.

3. Connect the vent line and the water inlet and outlet connections.

4. Connect the shutter control linkage.

5. Replace the protective hatch.

6. Fill the system with properly-treated water.

REPAIRING DAMAGED RADIATOR CORES

Cores are constructed of thin-wall tubes which are passed through cooling fins and attached to tube sheets or headers at each end. Two specific types of construction are used by radiator manufacturers: the soldered-core construction and the brazed-core construction. Maintenance of each core construction differs from the other; exercise care to determine the construction of the core being repaired.

Brazed-construction cores have seamless copper tubes fitted through copper cooling fins and brazed to a copper-alloy header.

Soldered-construction cores are comprised of lock-seam, soldered copper tubing fitted through copper cooling fins and soldered to a copper-alloy header.

Identification of the construction may be determined by scraping the braze or solder at the joint between the tube and the header with the blade of a pocket knife. If the metal uncovered is soft and white, the construction is soldered; if the metal is harder and has a yellowish hue, it indicates a brazed construction.

REPAIRING DAMAGED BRAZED CORES

1. When a leak is discovered during the test, clean the immediate area around the hole with a wire brush.

2. Apply flux (Handy Flux, or equivalent) to the cleaned area, and heat with an oxygen-acetylene torch giving a carbonizing flame that will produce sufficient heat.

> **CAUTION:** *To prevent burning the material, exercise care when using an oxygen-acetylene torch.*

3. Brazing may be accomplished with "Silfos", "Phosco" or other similar brazing wires. Either material may be used, since they mix readily.

4. After the brazing is completed, the repaired area must be soaked or washed with hot water to dissolve any flux or impurities.

5. The core then should be dried internally and tested at 20 psi air under water. If any leaks appear, the process should be repeated.

6. The repaired cores should be reassembled and the radiator tested for leaks before being reapplied to the locomotive.

REPAIRING DAMAGED SOLDERED CORES

1. Clean the area around the leak, using a wire brush. Then apply flux (Grasseli No. 41 or equivalent). This flux is diluted in a mixture of 50-percent water to a Baume reading of 28 to 32 degrees.

2. Heat the area to be soldered, using a gas torch adjusted to a soft flame.

3. After the area is sufficiently heated, apply 35/65 wire solder (35-percent tin, 65-percent lead). Apply ample heat to cause the solder to flow evenly over the affected area. If the area being soldered is between parts, such as the tubes and tube headers, a good fillet of solder should be built up around the joints.

CAUTION: *After repairing cores by soldering, assure all tubes are open and free of restrictions.*

4. After the soldering operation, wash the flux from the core, using cold water. The section then should be assembled and retested for leaks.

In cases where the tubes are too badly damaged or where a leak is located near the center of the core, recommended repair is made by sealing off both ends of the affected tubes. This may be accomplished by soldering brass plugs into each end of the tube. An alternate method to close off a tube is by crimping and soldering the tube ends.

CAUTION: *When repairing radiator cores, not more than five percent of the tubes per core section should be closed off.*

If more extensive repairs are required, the radiator core should be discarded or, if practical, returned to the factory for complete reconditioning.

After the radiator sections have been assembled and tested, they should be painted, using a standard radiator spray paint. To maintain maximum cooling efficiency, the thickness of the paint film should be kept to a minimum. Straighten any bent fin edges before painting.

WATER PUMP

Refer to Water Pump instructions, GEK-35947.

OIL COOLER

Refer to this subject in Lubricating Oil System instructions under TAB DE-13.

DATA

Water Capacity

With 8-cylinder engine	180 U.S. gal. (681 liters)
With 12-cylinder engine	200 U.S. gal. (757 liters)

Pressure Relief Valves (In Fill Cap)

Opening Pressure	6-8 psi
Air Leakage from 0.5 psi to Opening Pressure	None allowed

Radiator Fan

	Close	Open
Low Fan Speed Temperature Switch (WT-1)	168-172 F (76-78 C)	5-9 F (3-5 C) below closing
High Fan Speed Temperature Switch (WT-2)	178-182 F (81-83 C)	5-9 F (3-5 C) below closing
Engine High Temperature Switch (ETS) (if used)	196-205 F (91-96 C)	5-9 F (3-5 C) below closing
High Water Temperature Switch (HWTS) (if used)	208-212 F (98-100 C)	5-9 F (3-5 C) below closing
High Idle Temperature Switch (HITS) (if used)	158-162 F (70-72 C)	5-9 F (3-5 C) below closing

Cleaning Compounds

Manufacturer	Product	Concentration
Cleaning Solution - for radiator exterior and system interior:		
Turco Products, Inc.	Trec	2 oz. per gal.
Oakite Products, Inc.	Penetrant	2 oz. per gal.
De-scaling Solution - for system interior:		
Turco Products, Inc.	De-scaler	5 percent by volume
Oakite Products, Inc.	Oakite 32	10 percent by volume
Neutralizing Solution - for system interior after de-scaling:		
Turco Products, Inc.	Trec	1/2 oz. per gal.
Oakite Products, Inc.	Penetrant	1/2 oz. per gal.

Equivalent cleaners made by other manufacturers also may be used.

TRANSPORTATION SYSTEMS BUSINESS DIVISION, GENERAL ELECTRIC COMPANY, ERIE, PA. 16531

DE-12
1-82 (1000) TKD

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